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FOR

IN SITU FLUID TREATMENT SYSTEM AND PROCESS

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IN SITU FLUID TREATMENT SYSTEM AND METHOD

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BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to the treatment of fluids and, more particularly, to the *in situ* treatment of naturally occurring bodies of fluid. Fluids, e.g., gases and liquids, have a broad range of uses including, but not limited to, drinking, commercial, recreational, and industrial uses. Fluids are often withdrawn from naturally occurring sources for such use at other locations.

[0002] Naturally occurring bodies of fluid can include components that render the fluid unsatisfactory for certain uses. For example, sediment, pathogens, contaminants, germs, microorganisms, and various undesired solid particles can accumulate in naturally occurring bodies of fluid. Before the fluid can be used, it is often necessary to remove some or all of these undesired components from the fluid.

[0003] In some fluid treatment systems, the fluid is removed from the naturally occurring source along with the undesired components. At a remote location, the fluid is then treated to remove the undesired components such that the fluid is suitable for the intended use. Thereafter, the fluid is distributed to the location of its intended use. On the other hand, care must be taken to properly dispose of the undesired components that have been removed from the fluid. Most importantly, laws or regulations may make it illegal to return the undesired components to the naturally

occurring source of the fluid. As a result, the time and cost of properly disposing of the undesired components that have been removed can be significant.

[0004] In light of the drawbacks of removing the undesired components from the naturally occurring body of fluid, there is a need for a treatment process and system that do not remove the undesired components from the naturally occurring body of fluid. Another need exists for a system and process that more efficiently treat the fluid, thereby reducing the time and cost of treating the fluid. A need also exists for a treatment system and process that do not require a remote facility for treating the fluid.

SUMMARY OF THE INVENTION

[0005] The present invention provides a system and process for the *in situ* treatment of a fluid. In particular, the fluid in a naturally occurring source is treated *in situ*. The treatment removes at least a portion of at least one undesired component from the treated fluid. The treated fluid is then transferred from the naturally occurring source, whereas the undesired components that have been removed from the treated fluid are left in the naturally occurring source. After being transferred from the naturally occurring source, the fluid can be used as is, or the fluid can undergo further treatment, if necessary.

[0006] One example of the present invention is a process for treating a naturally occurring body of fluid. The process comprises providing a fine porous device and positioning the fine porous device in the body of fluid. A portion of the body of fluid is then passed through the fine porous device. Thereafter, the portion of the body of fluid is transferred to a location away from the remainder of the body of fluid.

[0007] The body of fluid may include at least one undesired component. At least a portion of the at least one undesired component may be blocked with the fine porous device such that the portion of the at least one undesired component is left in the remainder of the body of fluid.

[0008] The process may further include providing a coarse screen. The coarse screen may be positioned in the body of fluid such that a portion of the body of fluid passes first through the coarse screen and then through the fine porous device. A pump may also be provided. The pump may be positioned in the body of fluid to induce a flow of a portion of the body of fluid to be treated or an alternate, supplementary fluid to pass across the surface of the fine porous device. Another pump may also be provided such that it is in fluid communication with the portion of the body of fluid that has passed through the fine porous device. This pump may be used to transfer the portion of the body of fluid to a location away from the remainder of the body of fluid.

[0009] A structural support for the fine porous device may also be provided. The fine porous device may be secured to the structural support. The fine porous device and the structural support may be positioned in the body of fluid either before or after being secured together. The structural support may be a housing for the fine porous device.

[00010] A pump may also be provided for providing a reverse flow of a fluid. The pump may be placed in fluid communication with the fine porous device and another source of a fluid. The fluid from the other source may then be pumped into the body of fluid to clean the fine porous device.

[00011] Another example of the present invention is process for treating a naturally occurring body of water that includes at least one undesired component. This process may include any of the optional or preferred features of the above-described example. This exemplary process provides a porous membrane, as an example of the fine porous device, a structural support, a screen, and a pump. The porous membrane may be secured to the structural support, and the porous membrane, the structural support, and the screen may be positioned in the body of water. A portion of the body of water may be passed through the screen and then through the porous membrane. At least a portion of the at least one undesired component is blocked with the porous membrane such that the portion of the at least one undesired component is left in the remainder of the body of water. The pump is placed in fluid communication with the portion of the body of water, and it is adapted to transfer the portion of the body of water to a location away from the remainder of the body of water. The portion of the body of water is then transferred to the location away from the remainder of the body of water.

[00012] Another embodiment of the present invention is a fluid treatment system. The fluid treatment system may include any of the optional or preferred features of the above-described examples of the present invention. An example of the fluid treatment system comprises a naturally occurring body of fluid that includes at least one undesired component. A coarse screen may be positioned in the body of fluid. Also, a fine porous device is positioned in the body of fluid such that a portion of the body of fluid may pass through the coarse screen and then through the fine porous device. The

fine porous device is adapted to block at least a portion of the at least one undesired component when the portion of the body of fluid passes through the fine porous device. A conduit is provided having a first end portion and a second end portion. The first end portion is positioned in the body of fluid such that it is adapted to be in fluid communication with the portion of the body of fluid that has passed through the fine porous device. On the other hand, the second end portion is positioned outside of the body of fluid. A pump may be located outside of the body of fluid and connected to the second end portion of the conduit. The pump is adapted to transfer the portion of the body of fluid to the second end portion of the conduit.

[00013] In addition to the novel features and advantages mentioned above, other objects and advantages of the present invention will be readily apparent from the following descriptions of the drawings and exemplary embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[00014] Figure 1 is a perspective view of an example of a fluid treatment system of the present invention;

[00015] Figure 2a is a plan view of an exemplary implementation of a fluid treatment system of the present invention in a flowing source;

[00016] Figure 2b is an elevation view of the implementation of Figure 2a;

[00017] Figure 3a is a plan view of an exemplary implementation of a fluid treatment system of the present invention in a non-flowing, fluid source;

[00018] Figure 3b is an elevation view of the implementation of Figure 3a;

[00019] Figure 4a is a plan view of an exemplary implementation of a fluid treatment system of the present invention in a non-flowing, fluid source, with a supplementary fluid for cleansing the fine porous device from the fluid source side of the fine porous device;

[00020] Figure 4b is an elevation view of the implementation of Figure 4a;

[00021] Figure 5a is a plan view of an exemplary implementation of a fluid treatment system of the present invention with the *in situ* fine porous device in a vertical orientation;

[00022] Figure 5b is an elevation view of the implementation of Figure 5a;

[00023] Figure 6a is a plan view of an exemplary implementation of a fluid treatment system of the present invention with the *in situ* fine porous device in a horizontal orientation;

[00024] Figure 6b is an elevation view of the implementation of Figure 6a;

[00025] Figure 7a is a plan view of an exemplary implementation of a fluid treatment system of the present invention with the *in situ* fine porous device in an inclined orientation;

[00026] Figure 7b is an elevation view of the implementation of Figure 7a;

[00027] Figure 8a is an elevation view of an exemplary implementation of a fluid treatment system of the present invention with coarse screening;

[00028] Figure 8b is a plan view of the implementation of Figure 8a;

[00029] Figure 9a is a plan view of an example of a unitary fluid treatment system of the present invention; and

[00030] Figure 9b is an elevation view of the unit of Figure 9a.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENT(S)

[00031] The present invention is directed to an *in situ* fluid treatment system and process. The present invention will be described primarily herein with regard to treating a source of water or air. Nevertheless, the present invention may be used to treat any type of liquid or gas fluid. Furthermore, the present invention may be used to treat any type of source of the fluid. Examples of naturally occurring sources of fluid include oceans, gulfs, seas, lakes, ponds, streams, rivers, creeks, quarries, lagoons, channels, swamps, other bodies of fluid surrounded or defined by land or otherwise located on the earth's surface, and other similar bodies of fluid. Further examples of naturally occurring sources of fluid include the atmosphere and other similar bodies of fluid. With regard to each of the examples, it should be recognized that a naturally occurring source of fluid may be man-made or have man-made boundaries, e.g., a man-made lake or a lake having a dam as a boundary.

[00032] A naturally occurring source of fluid may include at least one component that is not suitable for a desired use of the fluid. Examples of undesired components include, but are not limited to, sediment, various other solids suspended in the body of fluid, pathogens, contaminants, germs, microorganisms, metal ions, aqueous salt, sugar, synthetic dyes, endotoxins, pyrogens, carbon black, viruses, tobacco smoke, gelatin, colloidal silica, albumin protein, paint pigment, bacteria, blue indigo dye, blood, dust, latex materials, emulsions, asbestos, milled flour, giardia cysts, yeast cells, coal dust, pollen, hair, sand, granular activated carbon, and other similar or known

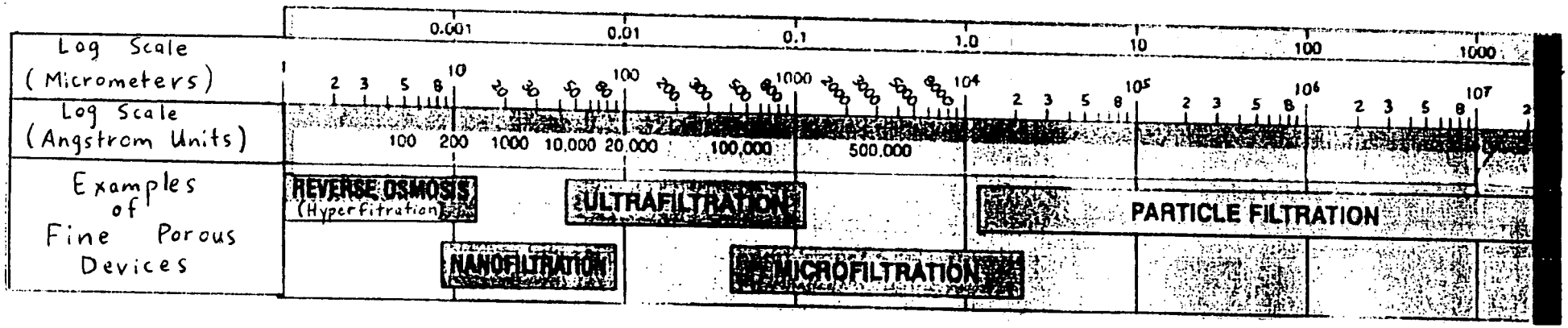
undesired components. Examples of pathogens include, but are not limited to, bacteria, protozoa, amoeba, viruses, and other similar or known organisms. Additionally, examples of microorganisms include, but are not limited to, giardia cysts, cryptosporidium, pseudomonas, E-coli, legionella, bacteria, coliform, protozoan oocysts, algae, and viruses. Furthermore, examples of other solids that may become suspended in the body of fluid include, but are not limited to, metals, inorganic solids, organic compounds, and other similar or known solids.

[00033] Figure **1** shows an example of a fluid treatment system **10** of the present invention. The system includes at least one fine porous device **12**. The fine porous device **12** is adapted to be suspended in a source of fluid. In addition, the fine porous device **12** is adapted to allow the passage of a portion of the fluid while blocking at least a portion of at least one undesired component in the fluid. The fine porous device **12** may be comprised of any suitable material including, but not limited to, plastics, textiles, metals, ceramics, cellulosic materials, and other similar, suitable, or conventional materials. Examples of the fine porous device **12** include, but are not limited to, ultrafilter membranes, microporous membranes, porous membranes, microscreens, nanofilters, reverse osmosis membranes, particle filters, and other similar, suitable, or conventional separation materials for filtering a fluid. A commercially available example of a porous membrane **12** is a microporous membrane from Zenon Environmental Services of Ontario, Canada.

[00034] The porosity of the fine porous device **12** may be selected based on the fluid, the amount and type of undesired components, the flow rate of the fluid, and the

desired degree of undesired component separation. Each of the aforementioned exemplary embodiments of fine porous devices are commercially available in a range of sizes that are well known in the art. Table **1** illustrates the sizing for some embodiments of the fine porous devices. Other embodiments of the fine porous devices may have sizes outside of the ranges shown in Table **1**.

Table 1



[00035] Optionally, the fine porous device **12** may be secured to a structural support **14**. The structural support **14** may be used for maintaining the position and/or shape of the fine porous device **12** in the fluid. The fine porous device **12** may be secured to the structural support **14** by any suitable means. For example, the fine porous device **12** may be secured to the structural support **14** with mechanical fastening means including, but not limited to, nails, screws, hinges, hooks, bolts, clamps, female connecting portions, male connecting portions, posts, receptacles, rods, axles, pins, chains, sprockets, belts, pulleys, springs, balls, sockets, hinges, trunnions, and clips. For another example, the fine porous device **12** may be secured to the structural support **14** using an interference fit.

[00036] The structural support **14** may have any suitable shape for maintaining the position and/or shape of the fine porous device **12** in the fluid. Optionally, the structural support **14** may substantially contain the fine porous device **12**, i.e., the structural support **14** may be a housing. Regardless of the shape of the structural support **14**, the structural support **14** allows a flow of the fluid through the fine porous device **12**. If necessary, the structural support **14** has at least one inlet portion **16** and outlet portion **18**. The structural support **14** may also have at least one side wall portion **20** to block a flow of the fluid from an undesired direction and/or to protect the fine porous device **12**.

[00037] The structural support **14** may be made of any suitable material. Examples of suitable materials include, but are not limited to, metal, wood, plastics, concrete, and other similar, suitable, or conventional structural materials. For instance, the structural support **14** may be made of steel.

[00038] A pipe, conduit, or any other similar, suitable, or conventional type of transfer passage is adapted to receive a flow of a fluid that has passed through the fine porous device **12**. In the example of Figure **1**, a pipe **22** is adapted to receive a flow of the fluid that has passed through the fine porous device **12**. For example, an inlet portion **24** of the pipe **22** may be: connected directly to the fine porous device **12**; connected directly to the outlet portion **18** of the structural support **14**; located adjacent the fine porous device **12**; located adjacent the outlet portion **18** of the structural support **14**; and/or located anywhere in the body of fluid such it is in fluid communication with a flow of the fluid that has passed through the fine porous device **12**. The pipe **22** or any other suitable transfer passage enables a flow of the fluid that has passed through the fine porous device **12** to be withdrawn from a remainder of a body of fluid. In an exemplary embodiment, the system may be effectively sealed such that only fluid that has passed across the fine porous device **12** may enter the pipe **22**.

[00039] An outlet portion **26** of the pipe **22** may be placed in fluid communication with a pump **28**. The pump **28** may be any type of pump suitable for pumping a fluid. The pump **28** may be used to draw the treated fluid through the pipe **22** away from the undesired components that have been blocked by the fine porous device **12**. Additionally, the pump **28** may be used to transfer the treated fluid to a location for further treatment or to a location where it may be used as is. Furthermore, the pump **28** may be used to provide a reverse flow of a fluid for cleaning purposes. For example, the pump **28** may be used to withdraw fluid from the source through pipe **22**, and then reverse the flow back into the source to clean the fine porous device **12**. For another

example, the pump **28** may be in fluid communication with another source of a fluid, and the pump **28** may be used to transfer fluid from the other source through the pipe **22** to the fine porous device **12**. In this manner, the fine porous device **12**, the structural support **14**, and/or the inlet portion of the pipe **22** may be cleaned. The fluid used for cleaning purposes may be the same as the fluid in the naturally occurring source or a fluid that includes cleaning agents.

[00040] Optionally, a coarse screen **30** may be provided. The coarse screen **30** may be used to provide additional filtration of the fluid. The coarse screen **30** may also be used to protect the fine porous device **12**. For instance, the coarse screen **30** may be used to block relatively large solid objects that are suspended in the fluid from reaching and damaging the fine porous device **12**. The porosity of the coarse screen **30** may be selected based on the desired degree of filtration, the desired degree of protection, and the type and size of the solids suspended in the fluid. The coarse screen **30** may be made of any material that is suitable for the intended purpose. Examples of suitable material include, but are not limited to, metal, wood, plastics, concrete, and other similar, suitable, or conventional structural materials. For instance, the screen **30** may be made of steel.

[00041] The system **10** may also include another pump **32**. The pump **32** may be disposed in the naturally occurring source of fluid. The pump **32** may be used to induce a flow of the fluid across the surface of the fine porous device **12**. The purpose of the pumping may be to provide a cleansing or scouring action by the flow of the fluid across the fine porous device. The pump **32** may be any type of pump that is suitable for

pumping or otherwise moving a fluid. It should be recognized that the pump **32** may be embodied as a fan or any other similar, suitable, or conventional device. The pump **32** may be used in any type of fluid source. The pump **32** is particularly useful when the fine porous device **12** is positioned in a fluid source that has an insufficient or otherwise unsuitable flow pattern. However, the pump **32** may also be used in fluid sources that have strong or otherwise suitable flow patterns.

[00042] As just noted, the present invention may be used to treated flowing as well as non-flowing sources of fluid. Figures **2a** and **2b** show the present invention being used to treat a flowing source, e.g., a source that has a flow induced by gravity or other natural forces. This embodiment of the treatment system includes an *in situ* fine porous device **34**, a pipe **36**, and a pump station **38**. The fine porous device **34** is positioned in a source of fluid **40** that is flowing in the direction **42**. On the other hand, Figures **3a** and **3b** depict a system of the present invention being used to treat the liquid fluid of a non-flowing source **44**. The exemplary treatment system comprises an *in situ* fine porous device **46**, a pipe **48**, and a pump station **50**. Since the source **44** is normally non-flowing, a pump, a fan, or any other suitable device is used to induce a flow as indicated by arrow **52** through the fine porous device **46**. Similarly, Figures **4a** and **4b** show a system including an *in situ* fine porous device **54**, a pipe **56**, and a pump station **58** being used to treat a non-flowing gas source **60** in which flows have been induced as indicated by arrows **62** and **64**.

[00043] The fine porous device of the treatment system may have any orientation that enables the passage of a flow of fluid while blocking at least a portion of at least

one undesired component in the fluid. Factors that may be involved in selecting the orientation of the fine porous device include the direction of the flow, the type of flow, and the type and size of the undesired components in the flow. Figures **5a** and **5b** show an exemplary treatment system including an *in situ* fine porous device **66**, a pipe **68**, and a pump system **70** being used to treat a fluid source **72**, wherein the *in situ* fine porous device **66** is vertically oriented. On the other hand, Figures **6a** and **6b** depict a horizontally-oriented *in situ* fine porous device **74**, a pipe **76**, and a pump station **78** being used to treat a fluid source **80**. In yet another embodiment, Figures **7a** and **7b** show a fluid source **82** that is being treated by a treatment system that includes an *in situ* fine porous device **84** having an inclined orientation, a pipe **86**, and a pump station **88**.

[00044] As discussed above, a treatment system of the present invention may include a screen. In Figures **8a** and **8b**, an exemplary treatment system is shown that includes a bar screen **90**, a fine porous device **92**, a pipe **94**, and a pump station **96**. The bar screen **90** and the fine porous device **92** are situated in a fluid source **98** having a flow in the direction of arrow **100**. The bar screen **90** may have any suitable shape. In this example, the bar screen **90** has a V-shape for directing certain undesired components around the fine porous device **92**, thereby providing additional filtering capacity as well as protecting the fine porous device **92** from potential damage.

[00045] The treatment system of the present invention may be formed as a single unit or multiple units. Figures **9a** and **9b** show an exemplary embodiment of a unitary treatment system **102** of the present invention. In this embodiment, the fine porous

device **104** is secured within a support system **106**. The support system **106** includes side walls **108**, an inlet structural support **110**, and an outlet structural support **112**. If desired, each of the side walls **108** may be non-porous so as to prevent a flow path in that particular direction. The inlet structural support **110** and the outlet structural support **112** connect the side walls **108** while providing a flow path to and from the fine porous device **104**. In this example, the bar screen **114** is integrally connected to the side walls **108** and/or the inlet structural support **110**. As a result, the treatment system **102** may be moved as a single unit.

[00046] As noted above, the treatment system may reverse the flow of fluid back across the fine porous device for cleaning purposes. In addition, the treatment system can be constructed and installed such that the natural flow transports the undesired components away from the fine porous device. In addition, the components of the treatment system may be cleaned by scouring, such as induced by fluid flow pumped across the fine porous device surface on the fluid source side. The fluid used may be the fluid to be treated, or may be composed of another fluid, solely, or in concert with the fluid to be treated. For example, treatment of water may incorporate pumping water across the fine porous device for cleaning or scouring, and may be further enhanced by also pumping air singularly or simultaneously across the membrane.

[00047] The present invention may be used alone or in conjunction with other conventional or new treatment methods. For example, the present invention may be used in conjunction with chemical treatment methods. The use of additional treatment

methods in addition to the present invention may or may not be advisable depending on the intended use of the fluid.

[00048] The exemplary embodiments herein disclosed are not intended to be exhaustive or to unnecessarily limit the scope of the invention. The exemplary embodiments were chosen and described in order to explain the principles of the present invention so that others skilled in the art may practice the invention. Having shown and described exemplary embodiments of the present invention, those skilled in the art will realize that many variations and modifications may be made to affect the described invention. Many of those variations and modifications will provide the same result and fall within the spirit of the claimed invention. It is the intention, therefore, to limit the invention only as indicated by the scope of the claims.